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The Non-local Universe: The New Physics and Matters of the Mind

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INTRODUCTION

This book is the product of a fifteen-year dialogue between a physicist and an historian and philosopher of science. The physicist has demonstrated expertise in computational science, astrophysics, earth systems science, general relativity, and the foundations of quantum theory; the historian and philosopher of science has written widely on the societal impacts of scientific and technological change. The decision to write a book for the general reader was motivated by our conviction that the discovery of nonlocality has more potential to transform our conceptions of the "way things are" than any previous discovery in the history of science. The implications of this discovery extend well beyond the domain of the physical sciences, and the best efforts of large numbers of thoughtful people will be required to understand them.

Perhaps the most startling and potentially revolutionary of these implications in human terms is a new view of the relationship between mind and world that is utterly different from that sanctioned by classical physics. René Descartes, for reasons we will discuss in a moment, was among the first to realize that mind or consciousness in the mechanistic worldview of classical physics appeared to exist in a realm separate and distinct from nature. After Descartes formalized this distinction in his famous dualism, artists and intellectuals in the Western world were increasingly obliged to confront a terrible prospect. The prospect was that the realm of

the mental is a self-contained and self-referential island universe with no real or necessary connection with the universe itself.

It is well-known that the problem of the homeless mind has been one of the central features and fundamental preoccupations of Western intellectual life since the seventeenth century. And there is certainly nothing new in the suggestion that the contemporary scientific worldview legitimates an alternate conception of the relationship between mind and world. Numerous writers of New Age books, along with a few well-known New Age gurus, have played fast and loose with the "implications" of the new physics in an attempt to ground the mental in some vague sense of cosmic Oneness. But if this book is ever erroneously placed in the New Age section of a commercial bookstore and purchased by those interested in New Age literature, they will be quite disappointed.

Our proposed new understanding of the relationship between mind and world is framed within the larger context of the history of mathematical physics, the origins and extensions of the classical view of the foundations of scientific knowledge, and the various ways that physicists have attempted to obviate previous challenges to the efficacy of classical epistemology. We will demonstrate why the discovery of nonlocality has forced us to abandon this epistemology and propose an alternate understanding of the actual character of scientific epistemology originally articulated by the Danish physicist Niels Bohr. This discussion will serve as background for understanding a new relationship between parts and wholes in quantum physics, as well as a similar view of that relationship that has emerged in the so-called "new biology" and in recent studies of the evolution of modern humans.

But at the end of this sometimes arduous journey lie two conclusions that should make the trip very worthwhile. First, there is no basis in contemporary physics or biology for believing in the stark Cartesian division between mind and world that some have rather aptly described as "the disease of the Western mind." And second, there is a new basis for dialogue between two cultures that are now badly divided and very much in need of an enlarged sense of common understanding and shared purpose—the cultures of humanists-social scientists and scientists-engineers. For the moment, let us briefly consider the legacy in Western intellectual life of the stark division between mind and world sanctioned by classical physics and formalized by Descartes.

CLASSICAL PHYSICS AND THE LEGACY OF DESCARTES

The first scientific revolution of the seventeenth century freed Western civilization from the paralyzing and demeaning forces of superstition, laid the foundations for rational understanding and control of the processes of nature, and ushered in an era of technological innovation and progress that provided untold benefits for humanity. But as classical physics progressively dissolved the distinction between heaven and earth and united the universe in a shared and communicable frame of knowledge, it presented us with a view of physical reality that was totally alien from the world of everyday life.

Descartes, the father of modern philosophy, rather quickly realized that there was nothing in this view of nature that could explain or provide a foundation for the mental, or for all that we know from direct experience as distinctly human. In a mechanistic universe, he said, there is no privileged place or function for mind, and the separation between mind and matter is absolute. Descartes was also convinced, however, that the immaterial essences that gave form and structure to this universe were coded in geometrical and mathematical ideas, and this insight led him to invent algebraic geometry.

A scientific understanding of these ideas could be derived, said Descartes, with the aid of precise deduction, and he also claimed that the contours of physical reality could be laid out in three-dimensional coordinates. Following the publication of Isaac Newton's *Principia Mathematica* in 1687, reductionism and mathematical modeling became the most powerful tools of modern science. And the dream that the entire physical world could be known and mastered through the extension and refinement of mathematical theory became the central feature and guiding principle of scientific knowledge.

The radical separation between mind and nature formalized by Descartes served over time to allow scientists to concentrate on developing mathematical descriptions of matter as pure mechanisms in the absence of any concerns about its spiritual dimensions or ontological foundations. Meanwhile, attempts to rationalize, reconcile, or eliminate Descartes's stark division between mind and matter became perhaps the most central feature of Western intellectual life.

Philosophers like John Locke, Thomas Hobbes, and David Hume tried to articulate some basis for linking the mathematical describable motions of matter with linguistic representations of external reality in the subjective

space of mind. Descartes' countryman Jean-Jacques Rousseau reified nature as the ground of human consciousness in a state of innocence and proclaimed that "Liberty, Equality, Fraternity" are the guiding principles of this consciousness. Rousseau also made god-like the idea of the "general will" of the people to achieve these goals and declared that those who do not conform to this will were social deviants.

The Enlightenment idea of deism, which imaged the universe as a clockwork and God as the *clockmaker*, provided grounds for believing in divine agency at the moment of creation. It also implied, however, that all the creative forces of the universe were exhausted at origins, that the physical substrates of mind were subject to the same natural laws as matter, and that the only means of mediating the gap between mind and matter was pure reason. Traditional Judeo-Christian theism, which had previously been based on both reason and revelation, responded to the challenge of deism by debasing rationality as a test of faith and embracing the idea that the truths of spiritual reality can be known only through divine revelation. This engendered a conflict between reason and revelation that persists to this day. And it also laid the foundation for the fierce competition between the mega-narratives of science and religion as frame tales for mediating the relation between mind and matter and the manner in which the special character of each should be ultimately defined.

Rousseau's attempt to posit a ground for human consciousness by reifying nature was revived in a somewhat different form by the nineteenth-century Romantics in Germany, England, and the United States. Goethe and Friedrich Schelling proposed a natural philosophy premised on ontological monism (the idea that God, man, and nature are grounded in an indivisible spiritual Oneness) and argued for the reconciliation of mind and matter with an appeal to sentiment, mystical awareness, and quasi-scientific musings. In Goethe's attempt to wed mind and matter, nature becomes a mindful agency that "loves illusion," "shrouds man in mist," "presses him to her heart," and punishes those who fail to see the "light." Schelling, in his version of cosmic unity, argued that scientific facts were at best partial truths and that the mindful creative spirit that unites mind and matter is progressively moving toward self-realization and undivided wholeness.

The British version of Romanticism, articulated by figures like William Wordsworth and Samuel Taylor Coleridge, placed more emphasis on the primacy of the imagination and the importance of rebellion and heroic vision as the grounds for freedom. As Wordsworth put it, communion with

the "incommunicable powers" of the "immortal sea" empowers the mind to release itself from all the material constraints of the laws of nature. The founders of American transcendentalism, Ralph Waldo Emerson and Henry David Thoreau, articulated a version of Romanticism that was more commensurate with the ideals of American democracy.

The Americans envisioned a unified spiritual reality that manifested itself as a personal ethos that sanctioned radical individualism and bred aversion to the emergent materialism of the Jacksonian era. They were also more inclined than their European counterparts, as the examples of Thoreau and Whitman attest, to embrace scientific descriptions of nature. But the Americans also dissolved the distinction between mind and matter with an appeal to an ontological monism and alleged that mind could free itself from all the constraints of matter in states of mystical awareness.

Since scientists during the nineteenth century were preoccupied with uncovering the workings of external reality and virtually nothing was known about the physical substrates of human consciousness, the business of examining the dynamics and structure of mind became the province of social scientists and humanists. Adolphe Quételet proposed a "social physics" that could serve as the basis for a new discipline called sociology, and his contemporary Auguste Comte concluded that a true scientific understanding of the social reality was quite inevitable. Mind, in the view of these figures, was a separate and distinct mechanism subject to the lawful workings of a mechanistic social reality.

More formal European philosophers, such as Immanuel Kant, sought to reconcile representations of external reality in mind with the motions of matter based on the dictates of pure reason. This impulse was also apparent in the utilitarian ethics of Jeremy Bentham and John Stuart Mill, in the historical materialism of Karl Marx and Friedrich Engels, and in the pragmatism of Charles Smith, William James, and John Dewey. All of these thinkers were painfully aware, however, of the inability of reason to posit a self-consistent basis for bridging the gap between mind and matter, and each was obliged to conclude that the realm of the mental exists only in the subjective reality of the individual.

MIND VERSUS MATTER AND THE DEATH OF GOD THEOLOGIAN

The fatal flaw of pure reason is, of course, the absence of emotion, and purely rational explanations of the division between subjective reality and exter-

nal reality had limited appeal outside the community of intellectuals. The figure most responsible for infusing our understanding of Cartesian dualism with emotional content was the death of God theologian Friedrich Nietzsche. After declaring that God and "divine will" did not exist, Nietzsche reified the "existence" of consciousness in the domain of subjectivity as the ground for individual "will" and summarily dismissed all previous philosophical attempts to articulate the "will to truth." The problem, claimed Nietzsche, is that earlier versions of the "will to truth" disguise the fact that all alleged truths were arbitrarily created in the subjective reality of the individual and are expressions or manifestations of individual "will."

In Nietzsche's view, the separation between mind and matter is more absolute and total than had previously been imagined. Based on the assumption that there is no real or necessary correspondence between linguistic constructions of reality in human subjectivity and external reality, he declared that we are all locked in "a prison house of language." The prison as he conceived it, however, was also a "space" where the philosopher can examine the "innermost desires of his nature" and articulate a new message of individual existence founded on will.

Those who fail to enact their existence in this space, says Nietzsche, are enticed into sacrificing their individuality on the nonexistent altars of religious beliefs and/or democratic or socialist ideals and become, therefore, members of the anonymous and docile crowd. Nietzsche also invalidated the knowledge claims of science in the examination of human subjectivity. Science, he said, not only exalts natural phenomena and favors reductionistic examinations of phenomena at the expense of mind. It also seeks to reduce mind to a mere material substance, and thereby to displace or subsume the separateness and uniqueness of mind with mechanistic descriptions that disallow any basis for the free exercise of individual will.

Nietzsche's emotionally charged defense of intellectual freedom and his radical empowerment of mind as the maker and transformer of the collective fictions that shape human reality in a soulless mechanistic universe proved terribly influential on twentieth-century thought. As we will discuss in more detail later, Nietzsche sought to reinforce his view of the subjective character of scientific knowledge by appealing to an epistemological crisis over the foundations of logic and arithmetic that arose during the last three decades of the nineteenth century. Through a curious course of events, attempts by Edmund Husserl, a philosopher trained in higher math and

physics, to resolve this crisis resulted in a view of the character of human consciousness that closely resembled that of Nietzsche.

The best-known disciple of Husserl was Martin Heidegger, and the work of both figures greatly influenced that of the French atheistic existentialist Jean-Paul Sartre. The work of Husserl, Heidegger, and Sartre became foundational to that of the principal architects of philosophical postmodernism, the deconstructionists Jacques Lacan, Roland Barthes, Michel Foucault, and Jacques Derrida. As we shall see, this direct linkage between the nineteenth-century crisis about the epistemological foundations of mathematical physics and the origins of philosophical postmodernism served to perpetuate the Cartesian two-world dilemma in an even more oppressive form. And it also allows us to better understand the origins of the two-culture conflict and the ways in which that conflict could be resolved.

CARTESIAN DUALISM AND THE TWO-CULTURE WAR

In the United States, French existentialism became the dominant philosophical tradition in institutes of higher learning in the 1960s, particularly in the humanities and social sciences. The writings of the French deconstructionists were embraced with much the same enthusiasm and fervor by students in these disciplines in American colleges and universities from the 1970s to the present. The legacy of this influence is now apparent in the large and growing number of scholars in the humanities and social sciences who embrace philosophical postmodernism. In the tradition of Nietzsche, the more extreme proponents of philosophical postmodernism seek to enact intellectual freedom in open rebellion against the knowledge claims of any discipline or knowledge field. Human consciousness in their view is inextricably connected with and dependent upon linguistic constructions of reality. And they also claim that there are no real or objective truths external to this reality.

In the absence of any basis for positing a real or necessary correspondence between linguistic constructions of reality and external reality, practitioners of philosophical postmodernism embraced Nietzsche's view of human subjectivity as a "prison house of language." Since they also assumed that any construction of reality in the mind of an individual "refers only to itself," these scholars concluded that unambiguous communication between individuals was an illusion at best and a species of mind-

less conformity to nonexistent external truths at worst. Like Nietzsche, they argued that the constructs and terms for constructing human reality are the arbitrary inventions of cultural forebears. And they also claimed these constructs and terms became foundational to the collection of narratives that constitutes any given culture because their creators had more power to "discourse" by virtue of their membership in "power elites" and "dominance hierarchies."

Armed with postmodern meta-theories, many scholars in the humanities and social sciences came to view all of human culture as a "text" or collection of narratives. This text, they argued, could be "deconstructed" to reveal the sources of repression and marginalization for women, ethnic minorities, racial groups, and third-world peoples. As the meta-theories entered the mainstream of graduate education in the humanities and social sciences, new modes of postmodernist thought rapidly emerged. The modes were identified with labels such as gender feminism, radical feminism, ecofeminism, gay and lesbian studies, Lacanian psychoanalytic theory, Marxist criticism, Afrocentrism, constructivist social anthropology, deep ecology, and Latourian sociology.

The postmodern posture toward science was also one of subversion. Based on the assumption that science is merely another cultural narrative articulated and perpetuated by those with the power to discourse, scholars in a variety of disciplines attempted to "deconstruct" these knowledge claims and expose their arbitrary origins in the subjective reality of their creators. Many of these scholars advanced the view that the hidden agendas in the "text" called science were products of Eurocentrism, colonialism, capitalism, sexism, and a variety of other "isms" associated with patriarchal Western culture.

The intent here, however, is not to denigrate the practitioners of philosophic postmodernism. It is to demonstrate that the Cartesian division between mind and matter became foundational to much of Western thought since the seventeenth century because it seemed utterly and incontrovertibly consistent with the worldview of classical physics. This division not only served as grounds for divorce between the world of quality, sense perception, thought, and feeling and the world of physical reality. It also laid the groundwork for the divisions between the Enlightenment ideal of the unification of all knowledge and the Romantic ideal of the ultimate integrity and supremacy of individual knowledge; between the conception of God as a creative and generative force in nature and the conception of God as the

distant and absentee clockmaker; between constructions of reality based on ordinary language and descriptions of physical reality in the mathematical language of physical theory; and, finally, but no less tragically, between the culture of humanists-social scientists and the culture of scientists-engineers.

Our proposed resolution of the two-world dilemma has substantive scientific validity and will be carefully developed in stages. Since we will draw extensively from knowledge on both sides of the two-culture divide, some of this discussion will at times prove intellectually challenging for members of both cultures. But if our thesis that advances in scientific knowledge have legitimated an alternate view of the relationship between mind and world that could obviate or displace the Cartesian view is correct, this could have large consequences for the future of Western thought.

SCIENCE AS A WAY OF KNOWING

Since much of this discussion deals with the epistemological authority of scientific knowledge, or the bases upon which the knowledge claims of science can be viewed as valid, we should make clear at the onset our position on this issue. Many well-educated humanists and social scientists, including some philosophers of science, have embraced assumptions about the character of scientific truths that serve either to greatly diminish their authority or, in the extreme case, to render these truths virtually irrelevant to the pursuit of knowledge. Those who promote these views typically appeal to the work of philosophers of science, principally that of Stephen Toulmin, Thomas Kuhn, N. R. Hanson, and Paul Feyerabend.

All of these philosophers assume that science is done within the context of a Weltanschauung, or comprehensive worldview, which is a product of culture and constructed primarily in ordinary, or linguistically based, language. One would be foolish to discount this view entirely, as we clearly do not in our brief history of mathematical physics. But it can, if taken to extremes, lead to some rather untenable and even absurd conclusions about the progress of science and its epistemological authority.

The views of the Weltanschauung theorists appear to have also lost currency of late among historians and philosophers of science. The approach that is now most widely endorsed by scholars in these fields is known as historical realism. Historical realism pays "close attention to actual scientific practice, both historical and contemporary, all in the aim of developing a systematic philosophical understanding of the justification of knowledge

claims."[1] From the perspective of historical realism, physics is a privileged form of coordinating experience with physical reality that has often obliged us to change our views of self and world.

It is also clear that the cumulative progress of science imposes constraints on what can be viewed as a legitimate scientific concept, problem, or hypothesis, and that these constraints become tighter as science progresses. This is particularly so when the results of theory present us with radically new and seemingly counterintuitive findings like the results of experiments on nonlocality. It is because there is incessant feedback within the content and conduct of science that we are led to such counterintuitive results.

The history of science also indicates that the postulates of rationality, generalizability, and systematizability have been rather consistently vindicated.[2] While we do not dismiss the prospect that theory and observation can be conditioned by extra-scientific cultural factors, this does not finally compromise the objectivity of scientific knowledge. Extra-scientific cultural influences are important aspects of the study of the history and evolution of scientific thought, but the progress of science is not, in our view, ultimately directed or governed by such considerations.

Obviously, there is at this point in time no universally held view of the actual character of physical reality in biology or physics and no universally recognized definition of the epistemology of science. And it would be both foolish and arrogant to claim that we have articulated this view and defined this epistemology. On the other hand, the view of physical reality advanced here is consistent with the totality of knowledge in mathematical physics and biology, and our proposed resolution of epistemological dilemmas is in accord with this knowledge.

In an interdisciplinary work of this kind, the list of those who should be thanked for their contributions is quite long. Suffice it to say here that we are quite grateful to all the men and women who produced the scholarship that made this study possible. If we have not fully disclosed the extent of these contributions, we apologize. The range and complexity of scholarship used here is vast, and space requirements, along with the decision to write a book for the general reader, did not allow for a full explication of this scholarship in all of its complex dimensions.